

WAKE UP, STOP DREAMING

Reassessing Japan's Reprocessing Program

Masafumi Takubo

Japan's reprocessing program is proceeding at full speed, despite concerns about its effects on international efforts to control nuclear proliferation. Testing of the Rokkasho Reprocessing Plant using actual spent fuel started on March 31, 2006, and the goal for commercial operation is February 2008. If started, Rokkasho will be the first commercial-scale reprocessing plant in a nonnuclear weapon state, capable of separating 8 metric tons (MT) of plutonium per year. If this occurs, under current plans the total amount of plutonium possessed by Japan will grow from about 45 MT to about 80 MT by 2011, close to the same amount of separated plutonium manufactured for the U.S. nuclear weapons program. This paper discusses the history of efforts to build and operate Rokkasho and whether there is any prospect for a change of direction. It argues that Rokkasho should not open before a dialogue among stakeholders can be held on alternative means of managing spent fuel, such as interim dry cask storage.

KEYWORDS: Japan; Rokkasho; reprocessing; proliferation; nuclear power

Notwithstanding concerns about nuclear proliferation, the Japanese government's latest long-term nuclear power plan, adopted in October 2005, confirmed plans to reprocess spent fuel from commercial power reactors. On November 16, 2006, Japan Nuclear Fuel, Ltd. (JNFL) announced that it had started to produce plutonium at the Rokkasho Reprocessing Plant in Aomori Prefecture, located at the northern tip of Honshu, Japan's main island. Active testing of the facility, which started on March 31, 2006, was scheduled to encompass five stages over seventeen months and reprocess 430 metric tons (MT) of actual spent fuel. Commercial operations are planned to begin in February 2008, with the plant reaching its full annual reprocessing capacity of 800 MT of spent fuel per year in 2009.

Originally, Japan intended to use separated plutonium to fuel fast breeder reactors (FBRs), which produce more plutonium than they consume. The FBR program stalled following a December 1995 serious sodium leak and fire at the Monju prototype FBR, located in Fukui Prefecture in western central Japan. The plan now is to mix plutonium with depleted uranium to make mixed oxide (MOX) fuel for light water reactors (LWRs). But this plan also has faced delays, leading to the accumulation of nearly 45 MT of separated plutonium (38 MT overseas and 7 MT in Japan) as of the end of 2006.¹

Rokkasho will be the first commercial-scale reprocessing plant in a non-nuclear weapon state. With a maximum annual capacity of 800 MT of spent fuel, Rokkasho can produce 8 MT of plutonium separated from fission byproducts each year, enough to make 1,000 Nagasaki-type bombs. Operating Rokkasho, which the Japanese government admits

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will be uneconomical, will make it harder to prevent other countries from using the Rokkasho example as an excuse to construct similar facilities with the intention of producing fuel for nuclear weapons.²

The following analysis examines the latest plans and characteristics of the Rokkasho complex and the prefecture hosting it, discusses how this present situation came about, and explores the prospect for a shift in direction.

Japan's Nuclear Power Plans

The mission of the Japan Atomic Energy Commission (JAEC), established in 1956, is "to plan, deliberate, and decide concerning basic policies or strategies for the promotion of research, development, and utilization of nuclear energy, to adjust the activities of administrative organizations concerned, to compile the budget for these organizations to pursue the policies."³ To fulfill this mission, JAEC has published a "Long-Term Plan for Research, Development, and Utilization of Nuclear Power" (hereafter referred to as the Long-Term Plan) approximately every five years since 1956. The latest report, the "Framework for Nuclear Energy Policy" (adopted in October 2005 by the Cabinet and hereafter referred to as the Framework) decided on the basic goals of: (1) continuing to meet at least 30–40 percent of Japan's electricity supply after 2030 with nuclear power generation, (2) further promoting a closed nuclear fuel cycle, and (3) commercializing a practical FBR around 2050.⁴ It set the timing of the start-up of the demonstration FBR (to follow the Monju prototype FBR) around 2030.

On August 8, 2006, the Nuclear Power Subcommittee of the Resources and Energy Advisory Council of the Ministry of Economy, Trade, and Industry (METI) adopted Japan's Nuclear Energy National Plan. Although this document is supposed to develop concrete plans for the goals put forth in the Framework, it actually advanced the timing of the demonstration FBR by five years to 2025 and that of a commercial FBR to "before 2050." It also assumed a second private reprocessing plant would be built, while the Framework merely said deliberations concerning the possibility of constructing a second reprocessing plant should start around 2010. The plan assumes that the second commercial reprocessing plant scheduled to start operation in 2045 (to coincide with the expected end of operations at Rokkasho) will reprocess FBR spent fuel and LWR MOX spent fuel in addition to ordinary LWR spent fuel.⁵

An October 31, 2006 report by a committee of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT), which is responsible for the research and development of nuclear technology, further solidified the plans and advanced the schedule.⁶ The demonstration 750-megawatt-electric (MWe) FBR to follow the prototype 280-MWe Monju FBR (to be restarted in fiscal 2008) is scheduled to go online around 2025, a commercial 1,500-MWe FBR around 2045, and operation of the second commercial reprocessing plant around 2040. The LWRs would be replaced gradually by FBRs and, around 2100, all Japan's nuclear power (assumed to be 58 gigawatts electric) would be supplied by FBRs.⁷

The plan for the final disposal of Japan's high-level nuclear waste is also facing difficulties. The Nuclear Waste Management Organization of Japan (NUMO) established

plans in October 2000 (in accordance with the 2000 Designated Radioactive Waste Final Disposal Act) to decide on the final disposal site for Japan's high-level radioactive waste by the latter half of the 2020s and to open it between 2033 and 2037. NUMO has been soliciting applications from local communities since December 2002, with the goal of deciding on candidate sites for further study around 2007. Some 10 local communities have shown tentative interest, most probably in order to receive subsidies—¥210 million (\$1.9 million) a year—for accepting just a paper study that lasts for two years. Because of the slow progress, the figure was raised to ¥1 billion (\$9 million) a year in April 2007, but no sites have been chosen for the initial paper study. Thus, opening a site by the 2037 deadline seems unlikely.

The Rokkasho complex contains the following facilities:

The Rokkasho Reprocessing Plant. The plant includes a storage facility for the product of reprocessing—the MOX powder of plutonium and uranium; a 3,000-MT capacity spent fuel storage pool; a high-level waste vitrification plant (which made its first products in November 2007 during plant testing); and a storage facility for the vitrified high-level waste generated by the plant. Construction costs have soared from the ¥760 billion (\$6.9 billion) estimate at the time of the 1989 construction application to ¥2.19 trillion (\$19.9 billion).

High-Level Radioactive Waste Storage Center. This center is for storing waste returned from overseas reprocessing plants; its 1,440-canister capacity, built at a cost of ¥80 billion (\$730 million), will eventually increase to 2,880 canisters. Since 1995, 1,310 canisters have been brought back from France, with the twelfth and final shipment occurring in March 2007. Shipments of about 850 canisters from the United Kingdom have been delayed due to technical problems there and will not begin until sometime in fiscal 2008 (April 2008–March 2009).

National Disposal Site for Low-Level Radioactive Waste. This disposal site is for waste from Japan's domestic nuclear power facilities, excluding waste from medical and other facilities.

Uranium Enrichment Plant. This plant's operating capacity is currently 300-ton separative work units (tSWU) per year (with five out of seven lines shut down), which will increase to 1,500 tSWUs in 2020. Built at a cost of ¥250 billion (\$2.3 billion), it fulfills 7 percent of Japan's domestic needs.

MOX Fuel Fabrication Plant. The maximum processing capacity of this facility will be 130 MT per year. Although construction did not begin as scheduled in October 2007, the planned startup date of October 2012 has not been revised. (Japan's plutonium currently stored in Europe is to be made into MOX fuel there before being shipped to Japan.)

Four facilities of the International Thermonuclear Experimental Reactor project are also planned for Rokkasho-mura village.

Aomori Prefecture's Dependence on Nuclear Facilities

Aomori Prefecture, with a population of around 1.5 million, ranked second-to-last in per capita income among the nation's 47 prefectures in 2004.⁸ Rokkasho-mura village in

Aomori Prefecture was selected for the nuclear fuel cycle complex primarily for one reason: a large-scale, economic development project for the area had failed in the early 1980s. A quasi-public corporation had bought nearly 53 square kilometers of land for its failed project, and the development company was left with a huge debt. Consequently, the nuclear fuel cycle project appeared to promise economic salvation for the region. The Federation of Electric Power Companies of Japan (FEPC) officially asked Aomori Prefecture to accept the project in July 1984. Less than a year later, in April 1985—surprisingly fast given the scale of the proposed project—then Governor Masaya Kitamura agreed to do so.

In addition to the Rokkasho complex, other nuclear facilities have also been sited in Aomori Prefecture: the Higashidori Nuclear Power Plant Site (with one unit operating and three more to be built); the planned Ohma Nuclear Power Plant (an advanced boiling water reactor with an output of 1,383 MWe), which could accommodate a full MOX core, as opposed to the one-third core of MOX in current reactors; and the planned Interim Spent Fuel Storage Facility in the city of Mutsu.

Aomori Prefecture is therefore heavily dependent on its nuclear facilities for income, which comes in the form of both central government subsidies and prefectural taxes on the facilities and the nuclear fuel brought into those facilities. The total amount of subsidies received by Aomori Prefecture and its municipalities from the central government under the 1974 so-called Three Laws on Power-Source Siting (the Electric Power Development Taxation Law, the Special Budget Law for the Development of Electric Power, and the Law for the Adjustment of Areas Adjacent to Power Generating Facilities), from fiscal 1989 to fiscal 2004, was ¥190 billion (\$1.7 billion), mostly related to the Rokkasho complex.⁹ Expected taxes on nuclear fuel and related material in the prefecture's fiscal 2005 budget amounted to ¥17.1 billion (\$16 million), accounting for 14.5 percent of its total tax income. The vast majority of this tax windfall, about 86 percent, came from the Rokkasho nuclear fuel complex, mostly for spent fuel brought in at ¥23,800 per kilogram (kg), or \$216/kg.

The village of Rokkasho-mura, with a population of about 12,000, is even more dependent on the fuel cycle complex. The village's total income in its fiscal 2005 budget was ¥12.22 billion (\$111 million); of this, more than half—¥6.9 billion (\$63 million)—came from village taxes. About 80 percent of the tax income was expected to come from the property tax on nuclear fuel cycle-related facilities. Thanks to the nuclear complex, Rokkasho-mura has a budget about twice that of villages of the same population in Aomori, and its per capita income in 2005 was highest in the prefecture, as it had been for several years. The cumulative special subsidies under the Three Laws on Power-Source Siting totaled around ¥25 billion (\$230 million) by the end of fiscal 2005, and were mainly used for building cultural, recreation, and social welfare facilities—the operating costs of which could become a huge burden in the future.

The Dream of Reprocessing

Japan once dreamed of FBRs as a limitless source of energy, producing more plutonium than they consumed. Reprocessing plants, used to separate plutonium from spent fuel, were envisaged as a necessary part of this cycle. But the “dream” of FBRs has proven far

more difficult to realize than expected. Despite this, the reprocessing program has moved forward—albeit behind schedule.

The first Long-Term Plan published by the JAEC in 1956 maintained that, “since the breeder reactor is considered to be best suited for the national conditions of Japan from mainly the standpoint of effective use of nuclear fuel resources, the goal shall be its domestic production.”¹⁰ The second Long-Term Plan (in 1961), however, found that “the fast neutron breeder reactor, which was considered to be an essential factor in an independent nuclear fuel cycle system, still has many technical difficulties as the research and development proceeds,” and moved the expected commercialization of the FBR to “the latter half of 1970s or later.” The 1961 plan also introduced the idea of MOX use in LWRs, stating: “We will proceed with research and development concerning the use of plutonium as a substitute for enriched uranium fuel.”¹¹

Reprocessing was originally thought to produce a net financial gain. Years later the proponents of reprocessing discovered that the opposite was true. A Ministry of International Trade and Industry (MITI) advisory group explained the discovery as late as December 2, 1981, as follows:

The present electricity generation accounting system is set up with the assumption that the value of the recovered uranium and plutonium would cover the reprocessing cost. The reprocessing is not regarded as part of costs in the calculation of the net price but put in as an asset in the rate base calculation. However, since it has become clear that the cost of reprocessing surpasses the value of recovered uranium and plutonium, the continuation of the current procedure would lead to unfair burden sharing among different generations of consumers of electricity.¹²

The group recommended creating a special reserve fund within power companies for the future cost of reprocessing, including for high-level waste vitrification, to be collected as part of the electricity fee. This led to the establishment of an internal reserve system in fiscal 1981, discussed below.

A Key Justification for Reprocessing

Arguing in favor of increasing the plutonium stockpile is difficult, so the lack of storage space for spent fuel has been frequently cited as a key reason for the need to open a reprocessing facility at Rokkasho. There is indeed a problematic dearth of spent fuel storage space. At the end of September 2006, the total amount of spent fuel stored at Japan's nuclear power plants was 11,650 MT. Japan's total effective storage capacity is only 18,930 MT, meaning that the pools at some power plants will eventually fill up.¹³ Because of this, the spent fuel pool constructed at the Rokkasho Reprocessing Plant, with a capacity of 3,000 MT, is being eyed as extra storage space. The cumulative amount of spent fuel received at the Rokkasho pool as of the end of October 2007 was 2,365 MT. If the reprocessing plant fails to open, this pool too will eventually fill up. However, there is still time to address the storage problem without operating the Rokkasho reprocessing plant.¹⁴ According to an analysis by Tadahiro Katsuta and Tatsujiro Suzuki for the International Panel on Fissile Materials, Japan has until around 2015 before its reactors

start running out of storage space, even without considering the joint use of the Mutsu interim storage facility by several power companies, or construction of additional off-site interim storage facilities. If pools at power plant sites and the Mutsu facility are shared among reactor operators according to need, Japan has enough storage space until around 2025.

From the beginning, Japan's unrealistic nuclear fuel cycle aspirations have been at odds with developing a prudent spent fuel storage policy. Once it became apparent that the spent fuel had to be kept on- or off-site for a long period of time, the government and the electric power companies made it difficult to secure the cooperation of the local governments. Although the central government has the authority to give permission to any changes at nuclear power plants, consent of the local governments is necessary, since most agreements between local governments (prefectures and municipalities) and reactor operators say that the local governments' prior consent should be obtained when building or modifying reactor facilities or related facilities. This applies to both the building and modification of spent fuel storage facilities and MOX-use plans.

Nuclear power plants in Japan first faced a shortage of spent fuel storage space in the 1990s. Operators tried various interim storage solutions, including adding dry cask storage, re-racking (placing fuel rod assemblies closer together in spent fuel pools), jointly using an existing storage pool for two or more reactors at one site, and constructing a new joint-use pool. As a result, the Fukushima-1 Nuclear Power Plant of the Tokyo Electric Power Company (TEPCO) now has a dry storage facility (completed in August 1995) and a joint-use pool (completed in October 1997).

In February 1993, as part of the prior-consent process for the construction of the joint-use pool, Fukushima Prefecture received a promise from the chief of the section in charge of MITI's nuclear power policy that the amount of the spent fuel stored at the plant would decrease after the start of the operation of a second private reprocessing plant, scheduled in 2010 (at that time, Rokkasho was scheduled to open in 2000). Two months later, based on this assurance, Fukushima Prefecture and the towns of Okuma and Futaba gave their consent to build the joint-use storage pool. (Because the plan for the dry storage facility discussed around the same time was to use an existing building, the prefecture considered it unnecessary to go through the prior-consent process for this.) But the 1994 Long-Term Plan shocked them. It stated: "concerning the second private reprocessing plant, a decision will be made around 2010."¹⁵ Because discussions about the 1994 Long-Term Plan had been intense as early as September 1992, there were suspicions in the prefecture that MITI might have known about the policy change when it offered assurances on the timing for the ultimate removal of the spent fuel from the pool.

This bitter experience was followed by the December 1995 Monju FBR sodium-coolant fire, caused by a simple error of the temperature sensors and compounded by subsequent cover-up attempts by the company operating the reactor concerning the video tapes and investigation of the accident scene. In January 1996, the governors of Fukushima, Niigata, and Fukui Prefectures, which collectively host some 60 percent of the reactors in Japan, released a proposal demanding that the central government "clarify concretely the whole picture for the future of the plu-thermal [MOX use] plan and the back-end measures, including accompanying problems, and show it to the related local

governments.”¹⁶ In both cases, the government's attitude and actions complicated its plans for promoting the interim storage of spent fuel.

The dry cask storage facility of Fukushima-1 Power Plant is the nation's first on-site dry cask facility. A second was completed in 2001 at Tokai-2 Nuclear Power Plant. In March 2003, in relation to the spent fuel storage tax levied by the city of Kashiwazaki, Isami Kojima, then vice president of FEPC (and current president of JNFL), while opposing the tax, hinted at the possibility of FEPC accepting such a tax if the spent fuel was allowed to be kept at power plant sites for a longer period of time as a solution to the urgent spent fuel problem.¹⁷ But this idea of on-site interim storage in exchange for a spent fuel tax has led nowhere due to the distrust of local communities.

The planning council for the 2005 Long-Term Plan (the Framework), consisted of 32 members chosen by JAEC—including its five members, the presidents of TEPCO, FEPC, and Japan Nuclear Cycle Development Institute—who compared the costs of four scenarios: (1) reprocessing all spent fuel; (2) reprocessing some spent fuel; (3) direct, permanent disposal of all spent fuel; and (4) temporary storage with a final decision to be made later.

Scenario 1 was found to be more expensive than Scenario 3: ¥5.2/kWh (\$.05/kWh) versus ¥4.5–4.7/kWh (\$.041–\$.042/kWh). The planning council dealt with this problematic imbalance with some creative accounting, adding a “policy change cost” to Scenarios 3 and 4. In addition to a ¥0.2/kWh (\$.002/kWh) charge covering the financial loss of the private sector for its investment in Rokkasho, a ¥0.7–1.3/kWh (\$.006–\$.012/kWh) charge for replacing nuclear power with fossil fuel plants was added. The result was ¥5.2/kWh versus ¥5.4–6.2/kWh (\$.05–\$.06/kWh) in favor of Scenario 1, making it appear that reprocessing of all spent fuel was the most economical alternative.¹⁸

The Framework argues that it takes time for communities hosting nuclear power plants to “understand the new policy of direct disposal and accept the temporal storage of spent fuel at the site” and that “it is likely that the nuclear power plants that are currently in operation will be forced to suspend operations, one after another, during this period due to the delay of the removal of spent fuel.”¹⁹ It assumes that these communities will relinquish subsidies and tax income related to nuclear power plants, automatically choosing to have the plants shut down. At the same time, it assumes that there will be communities that will accept a final disposal site quickly and that the Rokkasho reprocessing plant will run at the nominal capacity of 800 MT/year for 40 years.

Thus the Framework decided to follow the reprocessing path outlined in Scenario 1: “Spent fuel will be reprocessed, within the available reprocessing capacity, for the time being, and the surplus volume exceeding the capacity will be stored intermediately. Study on the measures to be taken for spent fuel stored at such interim storage facilities and spent MOX fuel from LWRs will start in around 2010.”²⁰

The Aomori Governor's “Threat”

Officials have exhibited a tendency to exaggerate the apparent lack of spent fuel storage space in order to promote reprocessing. Kumao Kaneko, the first director of the Nuclear Energy Division of the Ministry of Foreign Affairs, emphasized the problem of the shortage of space in a 2005 article published in the Japanese magazine *Energy*. After discussing the

ostensible reasons for reprocessing, such as reduction of waste volume, recycling of plutonium to utilize limited resources, and plutonium as semi-domestic resource, Kaneko goes on to explain the “real reason”:

Many of the nuclear power plants have the problem of spent fuel storage, with some reaching the limit of the storage capacity. Thus there is a need to bring that spent fuel into Rokkasho-mura village and reprocess it. If the operation of the plant is stopped, the agreement between the central government and Aomori Prefecture becomes void and the spent fuel that has already been brought into the plant must be returned to the original power plants. Then nuclear power plants in Japan will be forced to shut down, leading to an awful situation.²¹

Kaneko was referring to the July 29, 1998 agreement between the prefecture, village, and JNFL, with the FEPC as a witness. The agreement states: “In the case where it is extremely difficult to ensure the execution of reprocessing, upon consultation between Aomori Prefecture, Rokkasho-mura village, and JNFL, JNFL shall promptly take necessary and appropriate measures including the removal of the spent nuclear fuel from the site.”²² Although the agreement does not refer to an automatic return of spent fuel to the original sites, proponents for reprocessing, including Japan Atomic Industrial Forum (JAIF), use it as “proof” that there is no alternative but to operate the Rokkasho plant immediately. The Aomori Prefectural Government from time to time cites the agreement when it demands, as at a Framework planning meeting held on September 24, 2004, that all aspects of the nuclear fuel cycle proceed smoothly.

This is, in fact, what Aomori Prefecture desperately needs—smooth progress of all the plans and a smooth flow of income accompanying them. Each delay can mean a loss of income for the prefecture. For example, the present delay in the active testing schedule is expected to cause a loss of ¥14 billion (about \$127 million) in tax revenue for fiscal 2008 for Aomori Prefecture and Rokkasho-mura combined because unless the reprocessing plant passes a pre-use test before January 1, 2008, the plant cannot be considered an asset for taxation purposes.²³ Delays in the schedule for transporting spent nuclear fuel to the facility, resulting from the April 18, 2007 revelation of JNFL’s miscalculation of earthquake resistance of some critical equipment, are expected to result in a decrease in prefectural nuclear fuel tax income by ¥5 billion (about \$45 million) from the initially anticipated ¥13.8 billion (about \$125 million) for fiscal 2007.²⁴ Thus the Aomori governor’s threat should be seen as a carefully choreographed dance between the prefecture and the reprocessing promoters to scare the critics of the reprocessing policy. While Aomori Prefecture does not want to make the Rokkasho complex a de facto waste dump for spent fuel, reprocessing would turn spent fuel into three different forms of waste: vitrified high-level waste, transuranic waste, and low-level waste. Either way, Rokkasho will become an interim storage site.

How the Government Has Promoted Reprocessing

Former JAIF Vice-Chairman Kazuhisa Mori, explaining the situation of the early 1960s, said the electric power companies did not want to deal with reprocessing:

While recognizing that spent fuel contained useful plutonium, electric power companies were very reticent about daring the launch into reprocessing due to anticipated complications in disposal of generated wastes, and the extreme difficulty of finding suitable sites. The attitude was to wait and see what the U.S. would do and what the international situation would look like. Just at that moment, the sales pitch of reprocessing service came knocking at our door from the U.K. and France. The Japanese electric power companies jumped on this. The reason for this was that there was a requirement by the government to specify in the construction permit application where the spent nuclear fuel was to be reprocessed. This was due to a "government policy" which considered nuclear fuel recycle as an essential part of nuclear power with intent of making nuclear power generators adopt a [future] recycle system. However, in terms of procedure, it was necessary only to write down the "expected reprocessing site" onto the application. In the meantime, talks had begun beneath the surface between the electric power companies and government officials with the intent of making do with just the reprocessing contracts with the U.K. and France.²⁵

Mori goes on to explain that the electric power companies considered the project to construct the Tokai reprocessing plant as a nuisance. In 1967, the construction of the Tokai reprocessing plant started (with an original planned capacity of 210 MT of spent fuel per year), and the 1967 Long-Term Plan said that the commercial sector should build the next plant by 1985 based on the principle of reprocessing spent nuclear fuel domestically.

In 1974, an executive member of an electric company explained the situation to Tatusuo Ibara, an industry journalist, as follows: "The electric companies did not want to deal with the reprocessing plant on the private sector side. An official of the Science and Technology Agency (STA) threatened to withhold permission for construction of nuclear power plants if the electric power industry did not take on reprocessing."²⁶

The STA was effectively responsible for authorizing construction of nuclear power plants until 1977, when the responsibility was transferred to MITI. The applications around this time all specified that the spent nuclear fuel would be reprocessed at the Tokai facility, but it lacked the capacity to handle all the spent fuel generated by the reactors then under construction. The STA did not like this situation, and forced the electric power companies to announce the establishment of a committee to prepare for domestic reprocessing, which they did on May 23, 1974.²⁷

When the electric power companies later tried to obtain funds from the Export-Import Bank of Japan for the construction of the British Nuclear Fuels Ltd. (BNFL) Thermal Oxide Reprocessing Plant, to be built at Sellafield in the United Kingdom for reprocessing spent nuclear fuel from overseas, MITI said the funding from the bank would not be provided if the electric companies gave up the idea of building a reprocessing plant in Japan. Thus the electric companies were forced again to announce a "positive attitude" concerning the construction of a domestic reprocessing plant, which they did on July 25, 1975. The law to privatize reprocessing was passed on June 1, 1979.

Ibara writes that it was STA bureaucrats, wielding authority over construction permits, who made the electric power companies say that they wanted to build a reprocessing plant. He declares that it could even be termed a distortion of history to say

that “electric companies volunteered to do the reprocessing business,” stressing that one should not be fooled by official explanations different from the actual decision-making process carried out behind closed doors.²⁸

This game between bureaucrats and the electric power companies led to the formation of a unique reprocessing company mostly owned by electric companies. Japan Nuclear Fuel Service Limited was established on March 1, 1980, with the participation of some 100 companies.²⁹ It merged with Japan Nuclear Fuel Industry Limited to create Japan Nuclear Fuel Limited in 1992. About 75 percent of JNFL is owned by nine electric power companies and Japan Atomic Power Company (JAPC), with TEPCO leading the group with about 21 percent.³⁰ Thus, the electric power companies are both the owners and the customers of the Rokkasho reprocessing plant. Other companies, seeing an opportunity, decided to participate in the enterprise as well, but only on a smaller scale to minimize the financial risk.³¹

It is important to note that there is no law expressly requiring reprocessing. The law regulating nuclear reactors simply requires submission of an application containing information on “the method of spent fuel disposal” before permission can be granted for construction. The law further stipulates that giving permission should not lead to “hindrance of the execution of the planned development and use of nuclear power.” Should reprocessing be a prerequisite for a construction permit? On November 1, 2004, during the preparation of the Framework, the JAEC clarified the matter, stating that because the government policy has been to proceed with reprocessing as expressed in the Long-Term Plans, it is reasonable that the government confirm reprocessing plans of would-be operators of nuclear power reactors before permission is given for construction.³²

However, in an interview on November 15, 2005, less than a month after the publication of the Framework, JAEC Chairman Shunsuke Kondo stated that the reprocessing path was chosen by the industry, seemingly deflecting responsibility from himself and the JAEC:

Concerning reprocessing, although the Government has provided guidance, having constructed the Tokai reprocessing plant, the operator [of Rokkasho] has designed and promoted the project on the separate basis of its own thinking. Thus the Framework expects the reprocessing project operator to keep in mind at any time that it is under risk of bankruptcy, and conduct effective business, exercising entrepreneurial spirit, applying effective business risk management.³³

A Lost Opportunity

Although many observers thought that the 2005 Long-Term Plan would decide whether to allow the operation of Rokkasho, Kondo explained in the summer of 2004 that the review was not about this decision. Kondo argued that the reason some people tend to come to the “far-fetched conclusion” that the Rokkasho reprocessing plant should be abandoned was the coincidental timing of two things. “The reprocessing plant is about to start operating,” he stated, and “the part of the reprocessing cost that was not allowed to be dealt with in accounting procedures due to the low level of precision of the estimate has

now become evident leading to the discussion of who is to bear it." Kondo added, "Once the private power companies have decided to operate a reprocessing enterprise, it's not the role of the Atomic Energy Commission to tell them to stop it."³⁴

The debate on the cost-bearing that Kondo mentioned was related to the move toward liberalization and deregulation of the heavily regulated regional monopoly-based electricity market. The third round of deregulation was scheduled to come into force in 2005. The issue was who would pay for the cost of reprocessing (and associated waste disposal costs) of the spent fuel that had already been generated and was to be further generated. This led to a debate about the wisdom of reprocessing itself, even within METI, in 2002–2004.

Intragovernmental Debates

In 2002, when the debate on the deregulation of the electricity market was coming to a conclusion, a high-ranking METI official reportedly asked a FEPC official about the possibility of the electricity industry voluntarily declaring that it would give up the operation of the Rokkasho reprocessing plant, since the cost of reprocessing would be a hindrance to the liberalization process. The FEPC official declined to comment.³⁵

The internal debate is suspected as the cause of the July 2004 leak from inside METI indicating that calculations had been made in 1994 and 1998 showing that reprocessing would be more expensive than the once-through plan, in spite of Diet testimony by METI officials in March 2004 that no such analysis had been done. Yet two months later, a weekly magazine published by the *Asahi Shimbun* newspaper company reported on a PowerPoint-type document that circulated in the spring and showed the high cost of reprocessing; it was reportedly produced by somebody inside METI, possibly with the approval of a senior official. The document called for a nationwide debate on the nuclear fuel cycle.³⁶

Who Pays for Reprocessing?

When passing the revision of the Electricity Utilities Industry Law in 2003, which addressed the third round of deregulation, both houses of the Diet passed a resolution calling for the establishment of a financial system by the end of fiscal 2004 to deal with the back end of the nuclear fuel cycle.

While deliberations on the Framework were still underway, the "Law Concerning the Establishment and Management of the Reserve for Reprocessing of Spent Fuel at Nuclear Power Plants" was enacted on May 11, 2005. The law established a system to recover the costs for reprocessing at the Rokkasho plant from ratepayers and went into force October 1, 2005.

As mentioned above, the electric companies had already set aside their own funds for the construction and operation of Rokkasho. The ratepayers were paying into this fund through a surcharge on their electricity bill. Under the new system, it became possible for the electric power companies to charge customers a part of the cost not collected so far (including that for decommissioning of Rokkasho) for the spent fuel that had already been

generated. The new system only covers the spent fuel to be sent to the Rokkasho reprocessing plant. The decision concerning the excess capacity of the Rokkasho plant was to be made later.³⁷ A subcommittee of METI's Resource and Energy Advisory Council agreed to allow power companies have reserve funds for a second privately operated reprocessing plant starting with the fiscal year ending March 2007, a decision subsequently ratified by METI.

Thus, the period of oscillation within the government seems to be over for now. While the tone of the 2000 Long-Term Plan, published after the Monju accident, was weak (for example, there were no target dates for FBR development), the Framework was more assertive with the goal of introducing the commercial FBR set around 2050. As described above, subsequent documents published by METI and MEXT moved up the schedule, and the construction of a second reprocessing plant is now treated as a given. On October 5, 2006, at a meeting held in Aomori, Tadao Yanase, director of the Nuclear Energy Policy Planning Division of METI, showed the government's determination to promote reprocessing, saying, "with nuclear power, things will not go forward unless the government comes to the fore." He stressed that "the Japanese energy policy switched from the tendency of giving top priority to the liberalization and deregulation back to the attitude of putting top priority on energy security. The government will show the direction and make the first step."³⁸

Will the Dream Become a Reality?

It remains to be seen whether industry and the public will follow the government's lead and help implement the plans for completing the nuclear fuel cycle. JAEC Chairman Kondo explains the relationship between a second reprocessing plant and the introduction of the commercial FBR as follows:

Assuming the operation period of the Rokkasho reprocessing plant is 40 years, there will be a replacement time around 2050. . . . If we are to build a reprocessing plant, it would be common sense to build one that could also reprocess FBR spent fuel. . . . We can assume if it is confirmed that FBR is competitive by 2050, we can start the efforts for the introduction of FBR including the nuclear fuel cycle. . . . [Around that time] there will be a window of opportunity for the introduction. If we cannot make it for this opportunity, then the next one will probably be around 2080 or 2090.³⁹

These plans are more like an expression of desires. The promoters of the nuclear fuel cycle hope that the closure of Rokkasho, the startup of a second private reprocessing plant, and the introduction of the commercial FBR will all occur around the same time. They also hope the introduction of the commercial FBR can come before the end of the anticipated construction rush of LWRs for replacing Japan's existing reactors, starting around 2030.

However, the electric power companies do not seem too confident about the fate of the demonstration FBR. According to Japan's Nuclear Energy National Plan, "at the FBR cycle demonstration stage, costs and risks equivalent to those associated with light water reactor power generation will in principle be borne by the private sector, with the

government bearing a substantial share of the further costs." The reason is that "the risks that electric power utilities can take are limited amid the electricity market deregulation, and FBR technology is an extremely high-risk technology which still has a minimal record of commercial performance worldwide."⁴⁰

The electric power companies might also now think twice about a second commercial reprocessing plant, the full-scale discussion of which is scheduled to start around 2010. Baku Nishio of the Citizens' Nuclear Information Center (CNIC) says the electric companies will consider the economics of reprocessing more seriously and notes that the need for surveys and research concerning direct disposal of spent fuel is mentioned for the first time in the Framework.⁴¹ Although the Nuclear Energy National Plan suggests the government is willing to bear a substantial burden, the power companies might still be hesitant. The financial fallout caused by the July 2007 earthquake damage to the Kashiwazaki-Kariwa plant (with seven reactors) may be an important factor.

Two Possible Solutions

Japan's reprocessing policy has led to the accumulation of a large amount of plutonium. The inventory of spent fuel is also increasing, adding to the pressure for more reprocessing. Let us now look at these two accumulation problems and the proposed solutions: MOX fuel use in LWRs, and off-site interim storage of spent fuel.

Blending Excess Plutonium Into MOX Fuel

As mentioned earlier, the 1961 Long-Term Plan referred to "the use of plutonium as a substitute for enriched uranium fuel." This means consumption of surplus plutonium as MOX fuel in LWRs in a so-called plu-thermal program (use of plutonium in thermal-neutron reactors as opposed to fast-neutron breeder reactors).

In 1991, the Japanese government announced in "Concerning the Nuclear Fuel Cycle in Japan," a report published by the Nuclear Fuel Subcommittee of the JAEC, that it would "not possess more plutonium than necessary in the implementation of the nuclear fuel recycling program."⁴² In December 1997, Japan reiterated the policy of not possessing surplus plutonium in its Plutonium Utilization Plan of Japan, sent voluntarily to the International Atomic Energy Agency (IAEA), saying: "The nuclear fuel cycle is promoted based on the principle that plutonium beyond the amount required to implement the program is not to be held, i.e. the principle of no surplus plutonium."⁴³

The supply and demand forecast in the 1991 nuclear fuel cycle report showed a cumulative supply of 85 MT of plutonium for the period ending 2010 with a cumulative demand of 82–93 MT over the same period, with no anticipated surplus of plutonium in 2010. It is interesting to note that based on the report's forecast, the Rokkasho plant was supposed to supply 50 MT, with the same amount to be consumed by use in LWRs. As industry journalist Hiroshi Muto points out, if both these items had been eliminated, the present situation would be simpler.⁴⁴

Although there have been delays on the supply side, too, the delays on the demand side have turned out to be much more serious, with the result being the increase of plutonium possessed by Japan from around 2 MT at the beginning of the 1990s to nearly 45 MT by the end of 2006. If Rokkasho starts operating as planned, this total amount is expected to grow to 80 MT by 2011, close to the total amount of plutonium produced by the U.S nuclear weapons program from 1944 to 1988.⁴⁵

Because of the delay in FBR plans, in 1997 the Japanese government announced an ambitious plan to start using plutonium as MOX fuel in 16–18 LWR reactors by 2010. Masao Takuma, former JAIF vice-chairman, observed:

It was in 1997 that the Government decided to promote a nuclear fuel cycle with the “plu-thermal” program at its center. Before that, I think the government was publicizing the new reactors such as the fast breeder reactor as the “main” way to utilize plutonium coming from reprocessing, and the plu-thermal in light water reactors as the “secondary.” I think the Government made the judgment that the use of MOX fuel in light water reactors will be central in terms of plutonium utilization because the fast breeder reactor program was behind schedule and because a decision was made to withdraw from the ATR (Advanced Thermal Reactor). Based on this [plu-thermal] decision [of the Government], FEPC also announced the plu-thermal program of all the electric power companies in February 1997.⁴⁶

A flier put out in the name of the minister of METI, before the May 2001 referendum held in the village of Kariwa on the proposed plu-thermal program at the Kashiwazaki-Kariwa nuclear power plant, explained the need for the program:

Japan has declared internationally that it will not possess plutonium for purposes other than use as fuel. Since Japan’s use of plutonium for the time being will be mostly as fuel in nuclear power plants, if the plu-thermal plan does not go forward and the use in nuclear power plants does not proceed, it will become difficult to recycle spent nuclear fuel. If recycling is not done, spent fuel could not be sent to the recycling facility (Rokkasho-mura, Aomori Prefecture) from nuclear power plants. If spent fuel is to continue to build up at the nuclear power plant sites, the storage facilities will be filled up and spent fuel cannot be discharged and replaced with fresh fuel, which will cause power plants to be shut down. . . . If nuclear power plants generating one-third of electricity of this country were to be shut down, there would be problems such as electricity shortages.⁴⁷

It should be noted that the government says the purpose of the MOX use plan is to allow the Rokkasho reprocessing plant to start operating and thus separate more plutonium. Residents near the Kashiwazaki-Kariwa plant (and other nuclear power plants with plu-thermal programs) were not asked by the government or the electric power company whether they were willing instead to allow on-site interim storage of spent fuel. Despite the government’s efforts, on May 27, 2001, Kariwa village residents voted 1,925 to 1,533 against the MOX use program.

Kaneko, the above-mentioned former Ministry of Foreign Affairs official, summarized the situation in August 2005:

Originally, it was the policy of Japan to consume plutonium as fuel for fast breeder reactors. However, the FBR development program has been delayed greatly due to the sodium leakage accident of the prototype FBR Monju (1995) and a commercial FBR is not expected to be introduced until around 2050. In the meantime, plutonium will be mixed with uranium and made into MOX fuel to be consumed in light water reactors (the so-called "plu-thermal program") and thus no "surplus plutonium" is supposed to arise. In fact, the plu-thermal program is not proceeding as planned due to various reasons, such as inability to obtain the consent of local governments. Therefore in reality it will not be possible to avoid a situation where unused plutonium is accumulated.⁴⁸

The consent of local governments concerning MOX use plans has been difficult to obtain due to, among other things, the disclosure in 1999 that quality control data had been fabricated by BNFL for the MOX fuel to be used by the Kansai Electric Power Company (KEPCO); the cover-up problems of TEPCO that surfaced in 2002 (falsification of inspection records concerning cracks in reactor vessel shrouds and containment vessel leakage rates); and an accident involving eleven casualties at a KEPCO reactor in 2004. The power companies themselves have made it difficult to obtain local consent. Last July's severe earthquake damage to the Kashiwazaki-Kariwa nuclear power plant, including the unit planned for MOX use, will be another obstacle. Only two reactors have obtained both the license of the central government and the consent of local governments for MOX use: Genkai-3 of Kyushu Electric Power Company in March 2006, and Ikata-3 of Shikoku Electric Power Company in October 2006. It is expected to take four to five years from this stage of approval to the loading of MOX fuel into these reactors.

Since 2006, in response to an August 2003 JAEC decision arising out of proliferation concerns, the power companies have been required to announce before the beginning of each fiscal year (which runs from April to March) how they intend to consume the plutonium expected to be separated from their spent fuel at Rokkasho in that fiscal year. The Framework states that the 2003 decision was made with the aim "to achieve further transparency in the use of plutonium," in the context of "the principle of not possessing reserves of plutonium of which use is undetermined . . . in order to improve both national and international understanding and credibility regarding Japan's strict adherence to the peaceful use of plutonium."⁴⁹ The decision stipulates that the utilization plan should have the amount, location, and time period of the utilization of plutonium to be separated that year. But the actual plans only say that the plutonium to be separated at Rokkasho would be consumed as MOX fuel in 2012 or later. This just means that the plutonium has to be made into MOX fuel at the MOX fuel fabrication plant to be constructed next to Rokkasho, which is supposed to start operation in 2012.

The only certain thing is that the consumption of the plutonium from Rokkasho would not begin until the MOX plant starts operating. The plans do not mention the schedule for the consumption of the plutonium stored in Europe. If the priority is placed on the use of the plutonium stored in Europe, all the plutonium separated in the Rokkasho plant will keep accumulating there until at least 2020, at a pace of 8 MT a year.⁵⁰ The MOX fuel for the two front-runner reactors is expected to be fabricated in

Europe. Could the stated aim of the 2003 decision be achieved with this kind of “utilization plan”?

Can MOX Help Reduce the Plutonium Stockpile?

The first step to the solution of the accumulation problem is to stop further separation of plutonium. Setting aside the safety issues raised by the critics of MOX use plans, under the present policy, the MOX use plan will not lead to a reduction of separated plutonium. As mentioned above, the government says that the purpose of the MOX use plan is to start Rokkasho and thus separate more plutonium. And the infrastructure created for MOX use would be used to further justify more reprocessing. A better approach would be to halt work at Rokkasho in order to first have a meaningful discussion on how best to deal with the accumulated separated plutonium.

Conserving waste disposal space has often been cited as a major merit of reprocessing. The Framework, for example, says:

Reprocessing by extracting and using uranium and plutonium contributes to the reduction of the potential harm from high-level waste, the volume of HLW and the necessary area of the disposal site. . . . Furthermore, if the FBR and its fuel cycle system become practical, it is possible to reduce the residual radioactivity of HLW over a long period of time and drastically lower the environmental load of energy generated.⁵¹

However, the high heat level of spent MOX fuel complicates things. Because of this heat, more space will be required for either direct disposal of spent MOX fuel or disposal of the vitrified high-level waste from reprocessing of spent MOX fuel compared to spent uranium oxide fuel, and this would more than offset the space saved by the original reprocessing. The July 2000 report of Jean-Michel Charpin et al., commissioned by French Prime Minister Lionel Jospin, explains the special problems of spent MOX fuel as opposed to ordinary spent uranium oxide (UOX) fuel: “The heat emitted by spent MOX is very much greater on average than the heat emitted by spent UOX: this implies either placing the MOX fuel in interim storage for a longer period prior to definitive disposal, or storing less MOX in the same space. For the same cooling-off period, the space required to store MOX is three times more than the one for UOX.”⁵²

While the Framework talks about the day when the FBR and its fuel cycle system might become practical, it remains a dream for now. Furthermore, if one really believes in that dream, the most sensible thing would be to keep the spent fuel stored for the day when the dream comes true. (The fact that that dream would be accompanied by the circulation of large amounts of plutonium—a nightmare from a nonproliferation perspective—is another matter.)

The failure of the MOX fuel use programs led to the need to address the problem of accumulating plutonium. This is being done using the following two arguments:

1. At Rokkasho, plutonium and uranium are used to produce a MOX powder; since it is extremely difficult to separate plutonium from MOX, the Rokkasho reprocessing plant is proliferation resistant.

2. Reactor-grade plutonium separated from spent fuel coming from LWRs is not suitable for making nuclear weapons.

Both arguments have been thoroughly refuted by scientists outside Japan. Steve Fetter, dean of the School of Public Policy at the University of Maryland, disagrees with the first argument: "First, a mixture of uranium and plutonium oxides (MOX) is somewhat less attractive for bomb-building purposes than pure plutonium oxide, but any group that can build an implosion device can easily separate plutonium from MOX. The chemistry involved is much simpler than reprocessing."⁵³

It is also worth noting that the MOX product is much less dangerous to handle because it has been separated from the lethal radioactive fission byproducts. As for the second justification, "A Call on Japan to Strengthen the Non-Proliferation Treaty by Indefinitely Postponing Operation of the Rokkasho Spent Fuel Reprocessing Plant," signed in 2005 by 28 U.S. nuclear experts, including nuclear weapon designers, states: "Despite assertions to the contrary, terrorists could use civil plutonium to make potent nuclear weapons with a destructive power equivalent to at least 1,000 MT of TNT."⁵⁴ The Hiroshima bomb was equivalent to about 16,000 MT (16 kilotons).

The Framework planning council and bureaucrats working with it also argued that there is no difference between reprocessing and direct disposal in terms of proliferation. As their unusual argument goes, the temptation for diversion of plutonium will increase hundreds to tens of thousands of years after direct disposal because by that time, radioactive decay of the most dangerous fission byproducts will render the fuel easier to handle.⁵⁵

Changing definitions is one way of justifying the accumulation of plutonium. Former diplomat Kaneko, together with 46 volunteers of the Energy & Environment Email Forum, which he set up, said in a statement published on June 11, 2004: "Since plutonium in stock will be burned as fuel eventually, the purpose of use is clear, so it should not be regarded as so-called surplus (excess) plutonium."⁵⁶ Another method is to turn the image of "a problem country that is accumulating a large amount of separated plutonium" into that of "the only exemplary country that is allowed to do so." The Nuclear Energy National Plan boasts that as a result of its cooperation with the IAEA on strict safeguards measures, "Japan is the only country among the non-nuclear weapons states that has been allowed internationally to possess a nuclear fuel cycle (reprocessing of spent fuel and uranium enrichment) at a commercial scale," as if everybody else was found suspicious and their applications turned down.⁵⁷

Interim Storage As An Alternative to Reprocessing

The Long-Term Plan of 1987 finally pointed out the need for interim storage capacity. The Japanese government made a decision in 1997 to have off-site interim storage capacity by 2010, and an amendment to the Nuclear Reactor Regulation Law in 1999 established a system whereby companies can be licensed to operate such facilities. According to the law, "interim storage" means "off-site (away-from-reactor) storage."

The annual amount of spent nuclear fuel coming out of Japan's 55 nuclear power reactors is about 1,000 MT and is expected to grow further. Even operating at full capacity, the Rokkasho plant can only process 800 MT a year. Therefore the only way to keep operating Japan's nuclear power plants is to build interim storage facilities either on- or off-site. In the past, whether intended or not, reprocessing plants in the United Kingdom and France functioned as virtual interim storage facilities for Japan. A total of 7,100 MT of Japanese spent fuel was sent to the United Kingdom and France, beginning in 1969 and 1978, respectively. Because Japan reached its contracted limit for fuel shipments in June 2001, this "storage method" is not available, at least for now.

The first off-site interim dry storage facility is to be built at Mutsu City in Aomori Prefecture. The Recyclable Fuel Storage Co. (RFS), set up by TEPCO and JAPC, plans to start operation of the facility in 2010 to store a total of 5,000 MT of spent fuel: 4,000 MT for TEPCO, and 1,000 MT for JAPC.⁵⁸

One might think that the rapid construction of more interim storage sites would eliminate the need to start up Rokkasho in order to conserve space for spent fuel storage. Katsuta and Suzuki estimate that with an additional 30,000 MT of off-site capacity (equivalent to six Mutsus), reprocessing can be postponed until approximately 2050. The present idea of building off-site interim storage facilities, however, is based on the assumption that Rokkasho will continue operations. Only the amount exceeding the reprocessing capacity at Rokkasho is to be stored at interim storage sites, to be reprocessed later at a second reprocessing plant.

Ironically, the construction of interim storage facilities can even lead to further pressure for the construction of a second reprocessing plant. Right before signing the agreement on the Mutsu interim storage facility on October 19, 2005, Aomori Prefecture Governor Shingo Mitamura cited as one of the reasons for giving consent the assurance obtained from the related ministers concerning the construction of a second reprocessing plant and said, "It is vitally important that the reprocessing of all the spent fuel is the premise for the interim storage program. The spent fuel should not be kept in Mutsu city forever."⁵⁹ Thus, although the Framework says the deliberation on a second reprocessing plant should start around 2010, government ministers have assured Aomori Prefecture that a second reprocessing plant will be built. Of course, similar assurances were made to Fukushima Prefecture before it approved construction of the joint-use spent fuel pool at Fukushima-1 Nuclear Power Plant.

Time to Reassess the Current Policy

The operation of the Rokkasho reprocessing plant and preparations for a second reprocessing plant should be stopped in order to first have a sincere dialogue with local governments about the possibility of interim storage facilities, either on-site or off-site. All involved parties should understand that reprocessing requires interim storage of high-level waste. Thus, the choice for Japan today is between interim storage of spent fuel and interim storage of high-level waste, assuming the continuing use of nuclear power to generate electricity. Even if all the reactors were shut down tomorrow, the problem of how to manage the accumulated spent fuel would not go away.

To have a real dialogue or debate, a process different from the one taken by the planning council for the Long-Term Plan will be necessary. Despite fanfare about the debate on the reprocessing policy during the committee deliberation that produced the Framework, the outcome could easily have been guessed from the fact that only a few out of the thirty-two members were critical or skeptical about reprocessing when they were selected by JAEC to be on the committee. Hideyuki Ban, co-director of CNIC, who was on the committee, suggested at the first session of the committee that there should be a system where one-third of the committee was chosen from those critical of the current Long-Term Plan, one-third from those neutral, and one-third from those supporting it.⁶⁰ A forum along these lines should be formed to have a real debate—and independent proliferation experts should be actively involved in the discussions.

Members of the Diet should also be more involved in the policy process and held accountable for the decisions made concerning reprocessing. While Japan's Communist Party and the Social Democratic Party are opposed to reprocessing, there has not been much discussion in the Diet, and thus not much reported by the media either, about the proliferation aspect of the Rokkasho reprocessing plant. Taro Kono from the ruling Liberal Democratic Party (LDP) says that the LDP supports the operation of the Rokkasho reprocessing plant because it gets money from the electric power companies and that the Democratic Party, the largest opposition party, also supports it because it is dependent on the labor unions of the electric power companies.⁶¹ But only a relatively small number strongly support the current reprocessing policy.

Most Diet members do not seem to be interested in the debate about reprocessing. Much of the money collected from ratepayers as a surcharge on the electricity bill under the Three Laws on Power-Source Siting has been used for research and development on reprocessing and FBRs. The Three Laws funds have been handled as a special account, separate from the general account, and the energy technology development-related part of the funds has been used mostly for nuclear fuel cycle programs, without much scrutiny in the Diet. Diet members should get involved in the debate, understanding that it is not merely a debate between supporters and opponents of nuclear power; it is fundamentally about economics of nuclear power and the risks of proliferation.

Because of the lack of awareness in Japan about the implications of reprocessing on nuclear proliferation, one might think that the only way to change the reprocessing policy of Japan is through pressure from abroad. While the Bush administration's renewed interest in reprocessing seems to be giving hope to reprocessing proponents, a U.S. policy change back to an anti-reprocessing stance might lead to pressure for a change in Japan as well.⁶²

On the other hand, the fear about possible pressure from the United States in the future might have made the Rokkasho start-up plan go even faster than usual. Keiji Kanda, professor emeritus at Kyoto University, a well-known proponent of reprocessing, said in an interview for an industry paper on July 7, 2004, shortly before the last U.S. presidential election: "If you hesitate too long [about starting the Rokkasho reprocessing plant], the U.S. presidential election will be involved. If Mr. Kerry (from the Democratic Party) wins and a Democratic administration emerges, the Rokkasho reprocessing plant might not be able to even start uranium testing."⁶³

This uneasiness about U.S. pressure comes partly from the fact that the U.S. position against reprocessing during the Ford and Carter administrations occurred right around the time the Tokai reprocessing plant was getting ready for hot testing. Intense negotiations between Japan and the United States in the end led to adoption of a process suggested by the United States that produced MOX instead of pure plutonium dioxide at the plant. The delays of the shipment of spent fuel to reprocessing facilities in Europe caused by the U.S. policy coincided with a serious spent fuel storage problem at Fukushima-1 Nuclear Power Plant.

Proponents of reprocessing and FBRs in Japan seem to have been hoping that the Global Nuclear Energy Partnership (GNEP) initiative of the Bush administration would alleviate criticism about the Japanese reprocessing policy. They are ignoring some contradictions about Japan participating in GNEP, including the fact that the United States wants to develop the advanced “burner” reactor that burns plutonium as quickly as possible to avoid proliferation, while Japan has been working on a fast “breeder” reactor that produces more plutonium than it consumes.⁶⁴ The conclusion of a U.S. National Research Council report, published in October 2007, should also be heeded:

The cost of the GNEP program is acknowledged by the [Department of Energy] not to be commercially competitive under present circumstances. There is no economic justification to go forward with this program at anything approaching commercial scale. DOE claims that the GNEP is being implemented to save the United States nearly a decade in time and a substantial amount of money. In view of the technical challenges involved, the committee believes that the opposite will likely be true.⁶⁵

Conclusion

In 1956 the Japanese government had a dream that the FBR would be introduced quickly. In this dream, reprocessing spent fuel from LWRs was thought necessary to provide FBRs with starter fuel. As the FBR's development was much slower than anticipated, the use of plutonium as MOX fuel in LWRs has been promoted as a strategy to deal with a temporary surplus of plutonium while sometimes touted as an efficient way of using the uranium resources. But this has also faced problems. Thus, plutonium separated at reprocessing plants has been accumulating without actual demand for it, triggering proliferation concerns. Now the government and the electric power companies have published notional MOX utilization plans to justify the operation of the Rokkasho reprocessing plant. Since these plans are not convincing, the only remaining justification left for them for the start-up of the plant is the lack of spent fuel storage space caused by their own bad planning. But a careful study shows there still is time—at least until around 2015. It would be more prudent for them to freeze the Rokkasho program and have an honest dialogue with all stakeholders on methods to solve the storage problem, including the possibility of both on- and off-site dry cask storage, if they want to continue to operate the nuclear power plants without exacerbating the already enormous proliferation threat to international society that they have created.

Decades after the original 1956 dream, the Framework envisions that commercial FBRs will be introduced sometime around 2050, with reprocessing supplying plutonium

for these reactors. But it is time for Japan to wake up and change course. Otherwise, the plutonium dream could all too quickly become a proliferation nightmare.

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NOTES

1. IAEA, *Communication Received From Japan Concerning Its Policies Regarding the Management of Plutonium*, INFCIRC/549/Add.1/10, November 1, 2007, <www.iaea.org/Publications/Documents/Infircs/2007/infirc549a1-10.pdf>. Unlike its previous declarations to the IAEA, in 2007 Japan listed only the amount of "fissile plutonium" (plutonium-239) stored in Europe (excluding the isotopes plutonium-238, plutonium-240, plutonium-241, and plutonium-242), making the total look significantly smaller (by 12,600 kilograms) than it actually is. For the previous year's report, see IAEA, *Communication Received From Japan Concerning Its Policies Regarding the Management of Plutonium*, INFCIRC/549/Add.1/9, November 14, 2006, <www.iaea.org/Publications/Documents/Infircs/2006/infirc549a1-9.pdf>.
2. Japan Atomic Energy Commission, *Genshiryoku Seisaku Taiko* (Framework for Nuclear Energy Policy), October 2005. English translation at <www.aec.go.jp/jicst/NC/tyoki/taikou/kettei/eng_ver.pdf>.
3. JAEC website, "The Mission," <www.aec.go.jp/jicst/NC/about/index_e.htm>. Until the Central Government Reform of 2001, the JAEC secretariat was in the Science and Technology Agency (STA) and JAEC and STA jointly implemented nuclear power policy. The chair of the JAEC was the director general of the STA, a ministerial position. The downsized JAEC secretariat is now in the Cabinet Office together with the Nuclear Safety Commission. JAEC's five commissioners, including the chair, are appointed by the prime minister with the Diet's consent for three-year terms. Following the 2001 reform, the STA's responsibilities for research and development of nuclear power were transferred to MEXT and its responsibilities for the industrial promotion and regulation of nuclear power were transferred to METI, which was established primarily by reorganizing the Ministry of International Trade and Industry (MITI).
4. JAEC, "Framework for Nuclear Energy Policy," October 2005.
5. METI, "Genshiryoku Rikkoku Keikaku" (Plan to Establish the State on the Basis of Nuclear Power), August 8, 2006, an English summary of the plan can be found at: <www.enecho.meti.go.jp/english/report/rikkoku.pdf>.
6. MEXT, "Kosoku Zoshokuro Saikuru no Kenkyu Kaihatsu Hoshin ni Tsuite" (Concerning the Policy of Research and Development of Fast Breeder Reactor Cycle), November 2, 2006.
7. Japan Atomic Energy Agency, Executive Summary, "Phase II Final Report of Feasibility Study on Commercialized Fast Reactor Cycle Systems," <www.jaea.go.jp/english/rd/fs_leaflet.pdf>.
8. Economic and Social Research Institute, Cabinet Office, Government of Japan Annual Report on Prefectural Accounts for 2004, March 6, 2007, <www.esri.cao.go.jp/jp/sna/kenmin/h16/kenmin1.pdf>. Japan is divided into 47 prefectures, each of which has an autonomous government with a governor and assembly. Each prefecture is divided into municipalities, which are called Shi (city), Machi (town), or Mura (village), depending on the size of their population.
9. Hiroshi Ebato, "Aomoriken to Genshiryoku—Chiiki Shinko no Yukue" (Aomori Prefecture and Nuclear Power—Direction of Regional Development), *Daily Tohoku*, March 14, 2006.

10. JAEC, "Genshiryoku no Kenkyu Kaihatsu Oyobi Riyo ni Kansuru Choki Keikaku" (Long-Term Plan for Research, Development, and Utilization of Nuclear Power), 1956, <www.aec.go.jp/jicst/NC/tyoki/tyoki1956/chokei.htm#index00>.
11. JAEC, "Genshiryoku no Kenkyu Kaihatsu Oyobi Riyo ni Kansuru Choki Keikaku" (Long-Term Plan for Research, Development, and Utilization of Nuclear Power), 1961, <www.aec.go.jp/jicst/NC/tyoki/tyoki1961/chokei.htm>.
12. METI, "Denki Jigyo Shingikai Denkiryoukin Seidobukai Chukan Hokoku" (Interim Report of the Electricity Fee System Subcommittee, Electricity Enterprise Council), December 2, 1981, <www.meti.go.jp/feedback/downloadfiles/i90906bj.pdf>.
13. JAEC, 2006 White Paper on Nuclear Energy (in Japanese), p. 128, <www.aec.go.jp/jicst/NC/about/hakusho/hakusho2006/index.htm>. Effective storage capacity is defined as total storage capacity (one full core plus one discharge).
14. Tadahiro Katsuta and Tatsujiro Suzuki, "Japan's Spent Fuel and Plutonium Management Challenges," International Panel on Fissile Materials, September 2006, p. 19, <www.fissilematerials.org/ipfm/site_down/ipfmresearchreport02.pdf>.
15. Fukushima Mimpo, "Kunihen Ginen Kienu Ken" (Suspicion about the Central Government Linger on the Part of the Prefecture), April 21, 2002.
16. Letter to the prime minister, MITI minister, and STA general director from Eisaku Sato (governor of Fukushima), Ikuro Yirayama (governor of Niigata), and Yukio Kurita (governor of Fukui), *Kongo no Genshiryoku Seisaku no Susumekata ni Tsuite no Teigen* (Proposal Concerning the Way to Carry out the Future Nuclear Power Policy), January 23, 1996, reprinted in *Fukuiken no Genshiryoku* (Nuclear Power in Fukui Prefecture), March 2006, p. 172.
17. Isami Kojima, *Shiyozumi Kakunenryozoei ni Tsuite* (Concerning Spent Fuel Tax), March 5, 2003, <www.fepc.or.jp/news/topics/nuclear/20030305.html>.
18. Nuclear Power Policy Planning Council, "Kakunenryo Saikuru ni Tsuiteno Chukan Torimatome" (Interim Report on Nuclear Fuel Cycle Policy), November 12, 2004, English translation by the CNIC at <cnic.jp/english/topics/policy/chokei/longterminterim.html>.
19. JAEC, "Framework for Nuclear Energy Policy," p. 33.
20. Ibid., p. 34.
21. Kumao Kaneko, "Rokkasho Saishori Kojo ha Kakubuso no Tame Deha Nai" (The Rokkasho Reprocessing Plant Is Not for Nuclear Armament), *Enerugii (Energy)*, November 2005, p. 13.
22. JAEC, "Aomori Kenchiji no Goiken wo Kiku Kai/Shinkeikaku Sakutei Kaigi (Dai 8 Kai) Gijiroku" (Meeting to Hear the Views of Aomori Prefecture Governor/New Plan Planning Council Meeting (8th Minutes), <www.aec.go.jp/jicst/NC/tyoki/sakutei2004/sakutei10/siry05.pdf>.
23. "Saishori Enkide Zeishu 140 Okuen Sakiokuri" (With the Delay of Reprocessing, a Tax Income of 14 Billion Yen Postponed), *Too Nippo*, September 8, 2007.
24. "Honnendo no Kakunenryo Hannyu Hangen 269 Ton" (This Fiscal Year's Nuclear Fuel Shipment Cut in Half: 269 MT), *Too Nippo*, September 19, 2007. On the miscalculation, see JNFL press release, "Saishorikojo (Shiyozuminenryo Ukeire/Chozo Shisetsu) ni Okeru Dai 1 Channeru Bkkusu Setsudan Sochi Oyobi Nenryo Toriatsukai Sochi ni Kansuru Taishin Keisan no Gonyuryoku ni Tsuite" (On the Erroneous Inputs in Anti-Seismic Calculation Concerning the Number 1 Channel Box Shearing Machine and the Fuel Handling Machine at the Reprocessing Plant), April 18, 2007, <www.jnfl.co.jp/press/pressj2007/pr070418-1.html>.
25. JAIF, *Gensan Hanseiki no Karenda* (Calendar of the Half-Century of JAIF), p. 25.
26. Tatsuro Ibara, *Genshiryoku Okoku no Tasogare (Twilight of the Nuclear Power Kingdom)*, (Tokyo: Nihon Hyoron Sha, 1984), p. 211.
27. Ibid., pp. 197, 212.
28. Ibid., pp. 218–219.
29. See JNFL website, <www.jnfl.co.jp/english/history.html>.
30. JNFL, Yuka Shoken Hokokusho (Financial Report), June 30, 2006, <<https://info.edinet.go.jp/EdiHtml/main.htm>>.
31. Tatsuro Ibara, *Genshiryoku Okoku no Tasogare*, pp. 242–244.
32. Planning Council, 11th Meeting, November 1, 2004, Document No. 3, pp. 16–20, <www.aec.go.jp/jicst/NC/tyoki/sakutei2004/sakutei11/siry03.pdf>.
33. Kanto Intabyu (Leadoff Interview), *Journal of the Atomic Energy Society of Japan* 48 (2006), pp. 1–6.

34. Interview with Shunsuke Kondo by Kenji Kaneko, "Kakunenryo Risaikuru" (Nuclear Fuel Recycling), *Nikkei Ecology*, August 2004, p. 11.
35. Shota Tsukahara, *Kakunenryo Saikuru 20 Nen no Shinjitsu* (Nuclear Fuel Cycle—The Truth of 20 Years) (Tokyo: Nihon Denki Kyokai Shimbunbu, 2006), p. 89.
36. Anonymous, *9 Choen No Seikyusho—Tomaranai Kakunenryo Saikuru* (Bill for 19 Trillion Yen: The Fuel Cycle That Would Not Stop), Kakujoho (Nuclear Information) website, <kujoho.net/rokkasho/19chou040317.pdf>. See also Atsushi Yamada and Junichiro Yamaoka, "Joshitsu na Kaibunsho ga Uttaeru Kakunen Chushi" (Stoppage of Nuclear Fuel Cycle Advocated by a Quality Anonymous Document), *Shukan Asahi*, May 21, 2004, p. 131.
37. METI, "Back End Jigyo ni Taisuru Seido-Sochi ni Tsuite" (Concerning the Measures for the Back-End Programs), July 2005, <www.enecho.meti.go.jp/denkihp/bunkakai/22nd/shiryo3.pdf>.
38. "Kuniga Zenmen ni Tachi Saishori Suishin" (Government at the Forefront to Promote Reprocessing), *Too Nippo*, October 6, 2006.
39. Kanto Intabyu (Leadoff Interview), p. 4.
40. METI, "The Challenges and Directions for Nuclear Energy Policy in Japan—Japan's Nuclear Energy National Plan," December 2006 p. 39, <www.enecho.meti.go.jp/english/report/rikkoku.pdf>.
41. Baku Nishio, co-director, CNIC, personal interview with author, Tokyo, March 9, 2007; JAEC, "Framework for Nuclear Energy Policy," p. 34.
42. JAEC, "Wagakuni ni Okeru Kakunenryo Risaikuru ni Tsuite" (Concerning the Nuclear Fuel Cycle in Japan), August 2, 1981.
43. IAEA, "Communication Received from Certain Member States Concerning Their Policies Regarding the Management of Plutonium," INFCIRC/549/Add.1, March 31, 1998, <www.iaea.org/Publications/Documents/Infircs/1998/infirc549a1.pdf>.
44. Hiroshi Muto, *Purutoniumu Kuraishisu* (Plutonium Crisis), (Tokyo: Nikkan Kogyo Shimbun-sha, 1993), p. 91.
45. Katsuta and Suzuki, "Japan's Spent Fuel and Plutonium Management Challenges," p. 21. The United States produced 90.6 MT of weapon-grade plutonium in its military production reactors at the Hanford Reservation in Washington state and the Savannah River Plant in South Carolina. See U.S. Department of Energy (DOE), "Plutonium: The First 50 Years—United States Plutonium Production, Acquisition, and Utilization from 1944 through 1994," February 1996, <www.osti.gov/opennet/forms.jsp?formurl=document/pu50yrs/pu50y.html>.
46. Masao Takuma and Reiichiro Fujimori, *Shitte Nattoku Genshiryoku* (Learn and Understand Nuclear Power), (Tokyo: Nihon Denki Kyokai, 2005), pp. 30–31.
47. METI, "Purusamru Jisshi ha Nihon to Chiiki no Mirai no Tameni Hitsuyodesu" (The Implementation of the Plu-Thermal Program Is Necessary for the Future of Japan and the Region), <kakujoho.net/mox/hiranm.html>.
48. Kumao Kaneko, "Hibaku 60nen: Kakuheiki to Genshiryoku—Nihon no Jirenma" (Sixty Years since the Atomic Bombing: Nuclear Weapons and Nuclear Power—Japan's Dilemma), summary of the speech given at a North Asia Region Conference of International Physicians for the Prevention of Nuclear War, Hiroshima, Japan, August 20–21, 2005.
49. JAEC, "Framework for Nuclear Energy Policy," p. 22.
50. Katsuta and Suzuki, "Japan's Spent Fuel and Plutonium Management Challenges," p. 21.
51. JAEC, "Framework for Nuclear Energy Policy," p. 22.
52. Jean-Michel Charpin et al., "Economic Forecast Study of the Nuclear Power Option," Report to the Prime Minister, July 2000, p. 91, <fire.pppl.gov/eu_fr_fission_plan.pdf>.
53. Steve Fetter, Q&A, Kakujoho (Nuclear Information) website, "Japanese Zen Approach to Proliferation," May 15, 2005, <kakujoho.net/e/zen1.html>.
54. Union of Concerned Scientists, "A Call on Japan to Strengthen the Non-Proliferation Treaty by Indefinitely Postponing Operation of the Rokkasho Spent Fuel Reprocessing Plant," May 5, 2005, <www.ucsusa.org/global_security/nuclear_terrorism/japan-strengthen-the-nonproliferation-treaty.html>.
55. Nuclear Power Policy Planning Council, "Kakunenryo Saikuru ni Tsuiteno Chukan Torimatome" (Interim Report on Nuclear Fuel Cycle Policy), p. 4.

56. Energy & Environment Email Forum, "Wagakuni no Kakunenryo Saikuru Seisaku ni kansuru Teigen" (Proposal Concerning Japan's Nuclear Fuel Cycle Policy), June 11, 2004, <www.eecom.jp/040611teigen.htm>.
57. METI, *Genshiryoku Rikkoku Keikaku*, pp. 22–24.
58. Atoms in Japan, "TEPCO and JAPC Jointly Set Up Firm for Interim Storage in Mutsu," November 8, 2005, JAIF website, <www.jaif.or.jp/english/aij/member/2005/2005-11-08.pdf>.
59. Chiji, "Chukan Shisetsu Ukeire Seishiki Hyomei" (Governor Formally Announced the Acceptance of the Interim Facility), *Too Nippo*, Oct. 19, 2005.
60. Hideyuki Ban, *Genshiryoku Seisaku Taiko Hihan* (Criticism of the Nuclear Power Policy Framework), (Tokyo: Nanatsumori Shokan, 2006), p. 23.
61. Taro Kono, speech (in Japanese) at a meeting in Sendai, Miyagi Prefecture, August 11, 2006, <vanillachips.net/archives/20060827_1510.php>.
62. See U.S. Department of Energy, Global Nuclear Energy Partnership, "Why Do We Need Advanced Fuel Separation Technology?" February 6, 2006, <www.gnep.energy.gov/pdfs/factSheetPrimerAdvseperation.pdf>.
63. Tsukahara, *Kakunenryo Saikuru 20 Nen no Shinjitsu* (Nuclear Fuel Cycle—The Truth of 20 Years), p. 63.
64. U.S. DOE, "Why Do We Need Advanced Fuel Separation Technology?"
65. National Research Council, "Review of DOE's Nuclear Energy Research and Development Program," October 2007, p. S-9, <books.nap.edu/catalog.php?record_id=11998>.